Fishery Data Series Number 05-15

Copper River Burbot Stock Assessment, 2003

by
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April 2005

Alaska Department of Fish and Game   Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	\$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 05-15

COPPER RIVER BURBOT STOCK ASSESSMENT, 2003

by

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ABSTRACT

Baited hoop traps were used to capture burbot *Lota lota* from three sections of the Copper River in 2003. Each section was sampled for a five-day/four-night period with traps pulled, checked and reset daily in most instances. The goal of the sampling was to produce baseline information on length composition and relative abundance of burbot in the river prior to the possible development of a recreational fishery for this species. Large adult burbot (≥ 700 mm TL) comprised an estimated 4% of adult burbot (≥ 450 mm TL) sampled, a fraction presumed indicative of a negligibly exploited population. Immature burbot (300 – 449 mm TL) were in the majority for samples in the upstream section, were sampled with equal frequency with adults in the mid-river section and were in the minority in the downstream section. Estimated mean CPUE of immature burbot followed the same upstream-to-downstream declining trend, but mean CPUE estimated for adult burbot was similar in all three sections. Catch per unit of effort was considerably higher in the Slana River than elsewhere even though size composition of fish caught in that tributary was the same as fish caught in other parts of that section. Data from this field study will provide a baseline that will help detect a significant increase in fishing rates in the future. Such detection in future samples would be based on the virtual disappearance of large adults and a drop in mean CPUE to 0.40 adult burbot per set, half or less of what was observed in this study.

Key words: Burbot, *lota lota,* Copper River, length composition, catch per unit effort, hoop traps, fishing rates, test for overharvest

INTRODUCTION

The lakes of the Upper Copper/Upper Susitna Management Area (UCUSMA; Figure 1) have supported the largest burbot fishery in the state. The fishery was at its strongest for a 10-year period from 1977 to 1986 when harvest averaged over 9,000 burbot a year. The fishery peaked in 1985 with a harvest of over 19,000 burbot, which accounted for 71% of the statewide harvest (Mills 1986). Concerns for overexploitation resulted in the Alaska Department of Fish and Game (ADF&G) initiating research studies in 1986 to assess stock status and to estimate the sustained yield of burbot from Interior Alaska lakes (Parker et al. 1987-1989; Lafferty et al. 1990-1992; Lafferty and Bernard 1993; Taube and Bernard 1995, 1999, 2001, 2004; Taube et al. 1994, 2000). In 1988 the Alaska Board of Fisheries adopted a management plan (5 AAC 52.045, 1989) that directs the lake burbot fisheries in the UCUSMA be managed for maximum sustained yield. The department has since managed these fisheries with daily bag limits, closures and gear restrictions. Presently, the bag and possession limit for burbot from most lakes is five. One lake is closed to the retention of burbot (Tolsona Lake), one lake presently has a bag and possession limit of one burbot (Lake Louise), and several road accessible lakes have bag and possession limits of two burbot (Summit, Hudson, Moose, Susitna and Tyone lakes; 5 AAC 52.022, 2002). Use of setlines as a fishing gear was prohibited by emergency order in the Tyone River drainage and at Tolsona and Moose lakes in 1988, then in all of the UCUSMA by regulation in 1991. Since 1991 annual harvests have remained relatively stable between 1,000 – 3,000 burbot (Taube *In prep*).

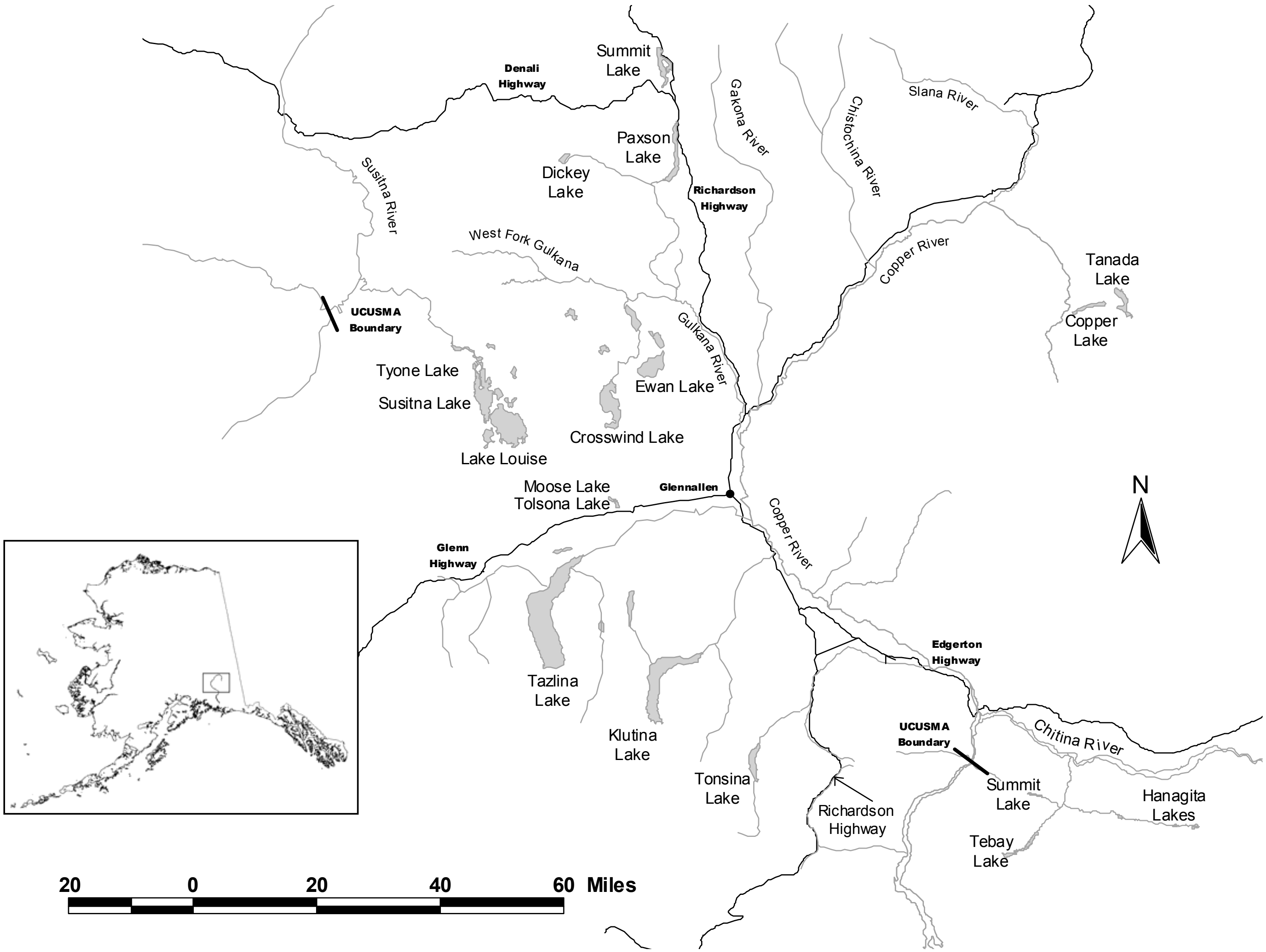

Figure 1.-Lakes and drainages of the Upper Copper/Upper Susitna Management Area.

Public interest for more opportunity to harvest burbot in the UCUSMA continues. In 1996 the Board of Fisheries established a personal use fishery for the mainstem Copper River. Under the authority of the Copper River Personal Use Burbot Fishery Plan (5 AAC 77.561, 1997), anglers were permitted to take five burbot per day by setline from the mainstem Copper River from November 1 through April 30. This fishery required the participants to obtain a permit, record their daily harvest and return the permit at the end of the season. In 1999 the plan was repealed due to lack of participation. In its place up to two setlines were permitted in the mainstem Copper River year-round under general UCUSMA sport fishing regulations. No burbot were reported harvested from the Copper River mainstem in 2000, seven burbot were reported in 2001, and no burbot were reported harvested in 2002 (Jennings et al. *In prep a*; Walker et al. 2003; Table 1). In 2003, the Alaska Board of Fisheries passed a proposal submitted by the department to increase the daily bag and possession limit from two to five burbot in the Copper River fishery, thus allowing the use of five unattended setlines (5 AAC 52.022, 2002). This proposal also expanded the area in which setlines may be used to include all east-bank tributaries of the Copper River and flowing waters of west-bank Copper River tributaries downstream of the Richardson and Glenn (Tok Cutoff) highways, excluding the Gulkana River.

The effect of this newly adopted regulation has yet to be seen, but could potentially increase fishing effort and harvest of burbot stocks in the mainstem and tributaries of the upper Copper River. Popular river burbot fisheries exist elsewhere in Alaska. Average statewide sport fish harvest of burbot in Alaska rivers estimated from the Statewide Harvest survey was approximately 8,000 fish per year from 1991 – 2002 (Taube *In prep*). Estimated burbot harvests in the Copper River and its major tributaries have been low during this time period, ranging from 0 (five different years) to 279 burbot per year (Table 1). Although the department has not assessed the burbot population in the Copper River, the amount of estimated harvest is considered negligible at this time.

The goal of this project was to collect sufficient size-composition data from the population which, in addition to harvest data, would afford the capability to detect overharvest from the burbot population in the Copper River should effort and harvest increase in future years. A shift in the size composition of the adult burbot population towards smaller fish coupled with a substantial increase in harvest would signal the effect of intense exploitation. Presently, the Copper River burbot population is negligibly exploited providing an opportunity to estimate size composition “before” a more intensive fishery becomes established. Once there is evidence that the fishery has grown, a second “after” sample can be taken in a later year to determine if size composition has changed to the extent that new regulations may be proposed. Regulations to reduce harvest may be proposed when the instantaneous fishing rate matches or exceeds the instantaneous natural mortality rate (by theory maximum surplus production is realized when these instantaneous rates are equal), and this will be inferred when there is a decline in the relative abundance of large fish in the sampled population. The magnitude of the decline in large fish that would indicate overfishing will be determined using length composition information from this study along with population statistics (e.g., instantaneous natural mortality, asymptotic length, and the growth coefficient) estimated from other burbot populations (e.g., Evenson 1998).

Table 1.-Estimated harvests of burbot from the mainstem Copper River and its major tributaries, 1985-2002.

	Year																	
Drainage	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Copper River mainstem	0	0	0	0	56	0	0	17	0	0	0	0	0	0	0	0	0	0
Chistochina River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chitina River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gakona River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gulkana River	0	88	45	18	19	17	18	129	0	0	7	48	26	17	0	12	0	106
Klutina River	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Slana River	35	202	0	0	0	0	0	8	225	52	7	0	0	0	101	0	0	0
Tazlina River	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0
Tonsina River	0	0	0	0	0	0	0	8	54	0	0	0	0	0	0	0	7	0
Total of all rivers	70	290	45	18	75	17	18	162	279	52	14	81	26	17	101	12	7	119
Total of all rivers, excluding Gulkana	70	202	0	0	56	0	0	33	279	52	7	33	0	0	101	0	7	13

Note: data from Mills 1986 – 1994; Howe et al. 1995, 1996, 2001a-d, Walker et al. 2003, Jennings et al. 2004, *In prep a*.

Additionally, this project sought to collect information to provide to anglers on relative density and size composition of burbot in different sections of the river that are most likely to be utilized by anglers.

The specific research objective of this project was to:

> gather length information to the extent where, in a future year, we may test the hypothesis that the portion of the population comprised of fish ≥ 700 mm TL is the same as in 2003 such that a drop of seven percentage points in the fraction can be detected with 90% power 95% of the time.

Project tasks were to:

1. estimate length composition of burbot from three sections of the Copper River; and,
2. calculate for three sections of the Copper River, mean CPUE for three length categories of burbot: small (300-449 mm TL), medium (450-699 mm TL) and large (≥ 700 mm TL).

METHODS

STUDY DESIGN

Sampling in the Copper River and the lower Slana River was restricted to three study sections (Figure 2). Study section I (27 mi in length) included the lower Slana River from the bridge on the Glenn Highway (Tok Cutoff) to the confluence with the Copper River, and the waters of the Copper River mainstem around the confluence of the Slana River and was sampled from 11-15 August. Study section II (22 mi in length) was sampled from 18-22 August and included the reach of the Copper River between the mouths of the Gakona and Tazlina rivers. Study section III (38 mi in length) was sampled from 22-26 August and included the reach of the Copper River from the Nadina River to the Chitina-McCarthy Highway Bridge. When possible, sampling was conducted in the lower stretches of tributaries within each study section.

Burbot were captured in 3-m long (small) hoop traps covered with treated 25-mm mesh net material. Bernard et al. (1991) describes these hoop traps in detail and provides information on the efficiency of these traps. In general, burbot are fully recruited to this gear at 450 mm TL. Catchability of burbot > 800 mm total length (TL) is about 40% of catchability for burbot 450 – 800 mm TL and burbot less than 300 mm are often able to swim through the mesh (Bernard et al. 1991; Evenson 1988, 1990-1993, 1998). Traps were set on the first day a study section was sampled, checked and reset in a different location the next three days, then checked and pulled on the last day. Traps were freshly baited each day with chopped Pacific herring *Clupea pallasi* placed in perforated plastic containers. Traps were set throughout study sections near both shores at least a quarter mile apart to avoid competition. Traps were set and retrieved from a boat.

Data were recorded by "set" and by burbot. A set was defined as a single hoop trap soaked at least one night in the same location. Most sets represent one net-night of fishing effort. Set number, hoop trap number, location of set (river mile upstream from Chitina-McCarthy Highway Bridge), hour trap was set and hour pulled, number of fish caught by species and date were recorded for each set on ADF&G hoop net mark-sense forms (version 1.0; Heineman *Unpublished*). Data forms were optically scanned and electronic data files (ASCII format) were produced for archival (Appendix A) and were imported into Excel spreadsheets for data analysis. Information recorded by individual burbot consisted of total length (TL) to the nearest

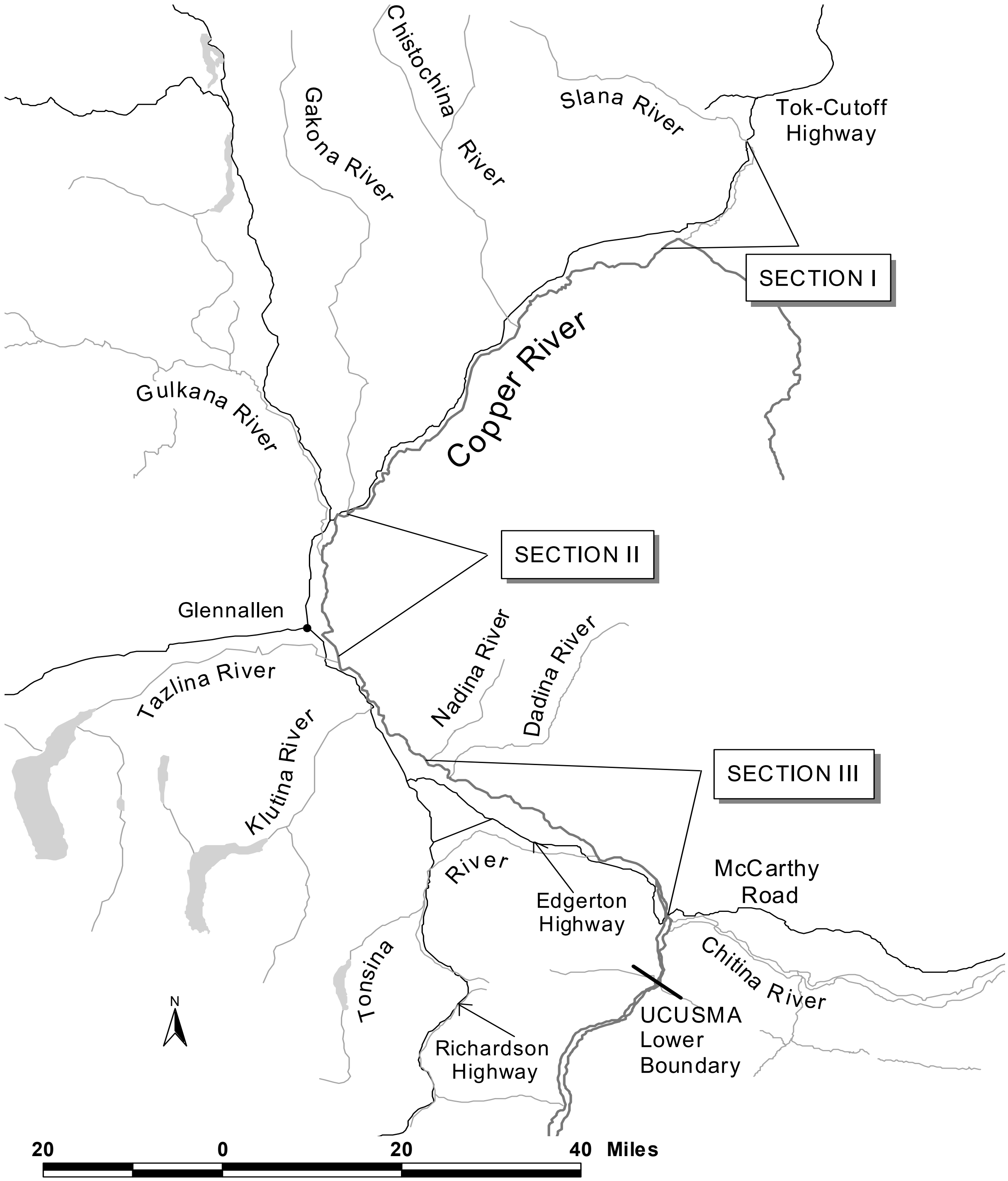

Figure 2.-Study sections in the Copper River drainage, 2003.

millimeter, date captured, set number, trap number and tag number. Each burbot was marked with an individually numbered internal anchor tag inserted between the pterygiophores located under the dorsal fin (all captured burbot were released alive). Burbot were not anesthetized for measurement or for tagging.

DATA ANALYSIS

Mean CPUE of burbot for each river section and for all sections together and their associated variances were estimated for each length category: immature fish (300 – 449 mm TL), small adult fish (450 – 699 mm TL) and large adult fish (≥ 700 mm TL). Statistics for each section were calculated as:

$$\overline{CPUE} = \left(\frac{1}{2}\right)\frac{\sum_{j=1}^{m'} c'_j}{m'} + \left(\frac{1}{2}\right)\frac{\sum_{j=1}^{m''} c''_j}{m''} \tag{1}$$

$$\mathrm{var}(\overline{CPUE}) = \left(\frac{1}{4}\right)\frac{\sum_{j=2}^{m'} (c'_{j-1} - c'_j)^2}{2m'(m'-1)} + \left(\frac{1}{4}\right)\frac{\sum_{j=2}^{m''} (c''_{j-1} - c''_j)^2}{2m''(m''-1)} \tag{2}$$

where c_j was the catch in set j, m was the number of sets in a section and the superscripts $'$ and $''$ referred to left and right banks of the river. Variance was estimated with the sums of differences between adjacent samples instead of the sums of deviations from the mean because the former formulation better approximates a variance from a systematically drawn sample (Wolter 1985). Catch per unit of effort was defined as the number of burbot captured per overnight set, or burbot per net-night. In a few instances traps where fished over two or more nights, information from these "sets" were not used to estimate mean CPUE. Estimates of mean CPUE for all sections combined were estimated as an average where k denotes section I, II, or III:

$$\overline{CPUE}_{I-III} = \frac{\sum_{k=1}^{3} \overline{CPUE}_k}{3} \tag{3}$$

$$\mathrm{var}(\overline{CPUE})_{I-III} = \frac{\sum_{k=1}^{3} \mathrm{var}(\overline{CPUE}_k)}{9}. \tag{4}$$

Length composition of burbot was reported by 50-mm categories beginning at 300 mm TL. As per findings in other studies (Bernard et al. 1991), burbot ≥ 450 mm TL were considered mature, fully recruited to the baited fishing gear used in the recreational fishery and fully recruited to the sampling gear used in this study. For these reasons, proportions to be used to detect decline in large fish from overharvest were based on adult fish only. The proportion of adults comprised of large fish (≥ 700 mm TL) was estimated as:

$$\hat{p} = n_L / n \tag{5}$$

$$\mathrm{var}(\hat{p}) = \frac{\hat{p}(1-\hat{p})}{n-1} \tag{6}$$

where n is the sample size of adult burbot (catch) in each of the three study sections or for all sections combined, n_L is the subset of n of large adults and $\hat{p}$ is the estimated fraction. The estimated fraction of smaller adults would be 1 - $\hat{p}$ and have the same estimated variance as $\hat{p}$.

RESULTS

From mid to late August 346 sets yielded a catch of 524 burbot ≥ 300 mm TL in three sections of the Copper River. Three hundred thirty-eight of the sets were overnight sets. In section I, 33 sets occurred in the mainstem Copper River (all overnight sets) and 76 in the Slana River (71 were overnight sets). In section II 114 sets were made, 113 of which were overnight sets. Of the 121 overnight sets in section III (123 sets occurred in all; two were accidentally left out for more than one night), seven sets occurred in the lower Tonsina River and five more in the mainstem Copper River near its confluence with the Tonsina River. No burbot were captured in these later 12 sets. Five hundred twenty-eight burbot were tagged and released (including some captured burbot < 300 mm TL), five were inadvertently killed, and one was captured twice (two days later and two miles upstream of initial release).

Analysis of samples indicated that size distributions of burbot ≥ 300 mm TL were dissimilar across the three sections. Cumulative length frequencies (Figure 3) were statistically different (Anderson-Darling test, D = 12.85, P < 0.01). Pairing up sections and comparing distributions revealed that the distribution for section I was the most dissimilar (Kolmogorov-Smirnov two-sample tests: I vs. II, D = 0.20, P < 0.01; I vs. III, D = 0.26, P < 0.01; II vs. III, D = 0.15, P = 0.06). Inspection of the data showed an upstream-to-downstream shift in distributions from immature burbot (300 - 449 mm TL) to small adults (450 – 699 mm TL; Figure 4, Table 2). Of fish < 700 mm TL, immature burbot comprised 60% of the sample in section I, 47% in section II, and 35% in section III, and this shift in percentages was statistically significant (I vs. II, χ^2 = 7.616, df = 1, P = 0.006, II vs. III, χ^2 = 4.405, df = 1, P = 0.036). This comparison did not include large adults (≥ 700 mm TL) because only 11 were captured. Sampling in the Slana River as part of section I did not affect this trend in relative size distributions across sections because relative size distributions were similar within section I. Nineteen immature burbot and 10 small adults were captured in the mainstem Copper River within section I, and 107 immature burbot and 68 adults in the Slana River (χ^2 = 0.202, df = 1, P = 0.653).

Estimates of mean CPUE for small adults were similar across all three sections while estimated mean CPUE for immature burbot trended downward from upstream to downstream sections (Table 3). Differences in estimated mean CPUE for small adults were not significant (II vs. III, t = 1.705, df = 232, P = 0.080). Differences in estimated mean CPUE for immature burbot were significant across sections (I vs. II, t = 3.592, df = 215, P < 0.001; II vs. III, t = 4.152, df = 232, P < 0.001). Estimated mean CPUE for both immature and small adult burbot in the Slana River was about three times higher than statistics for the nearby Copper River (Table 4). Too few large adults were captured in the study (11) to establish a trend in mean CPUE across sections or within section I.

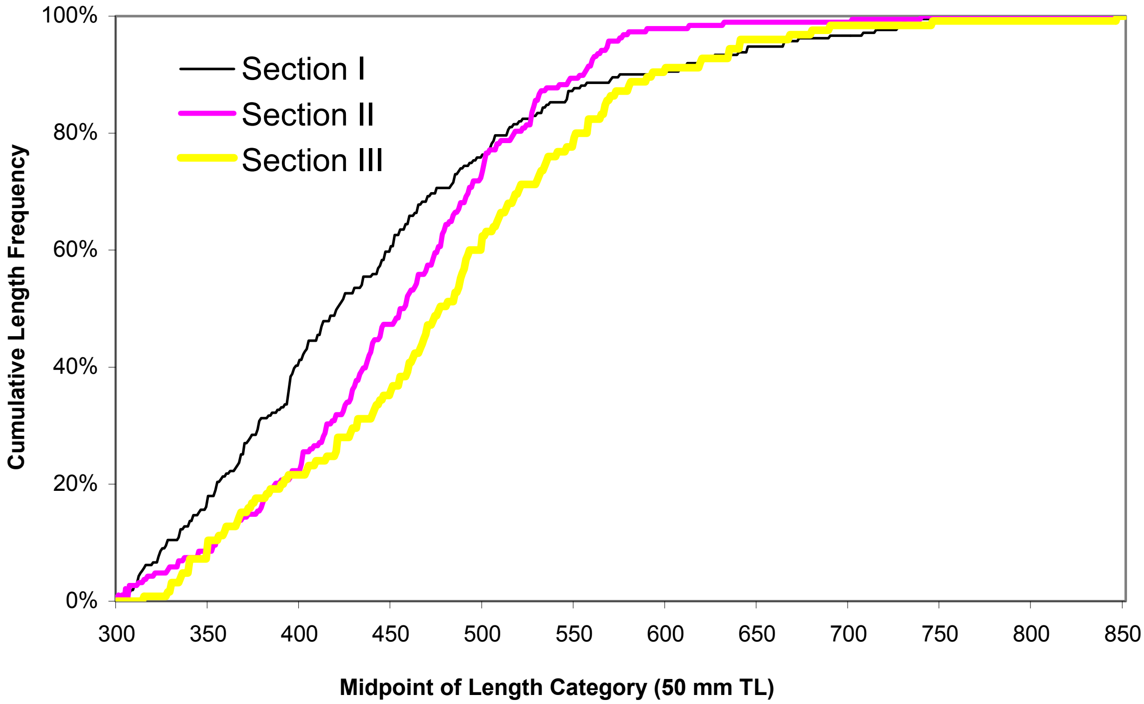

Figure 3.–Cumulative length-frequency distributions of burbot sampled from the Copper River, 2003.

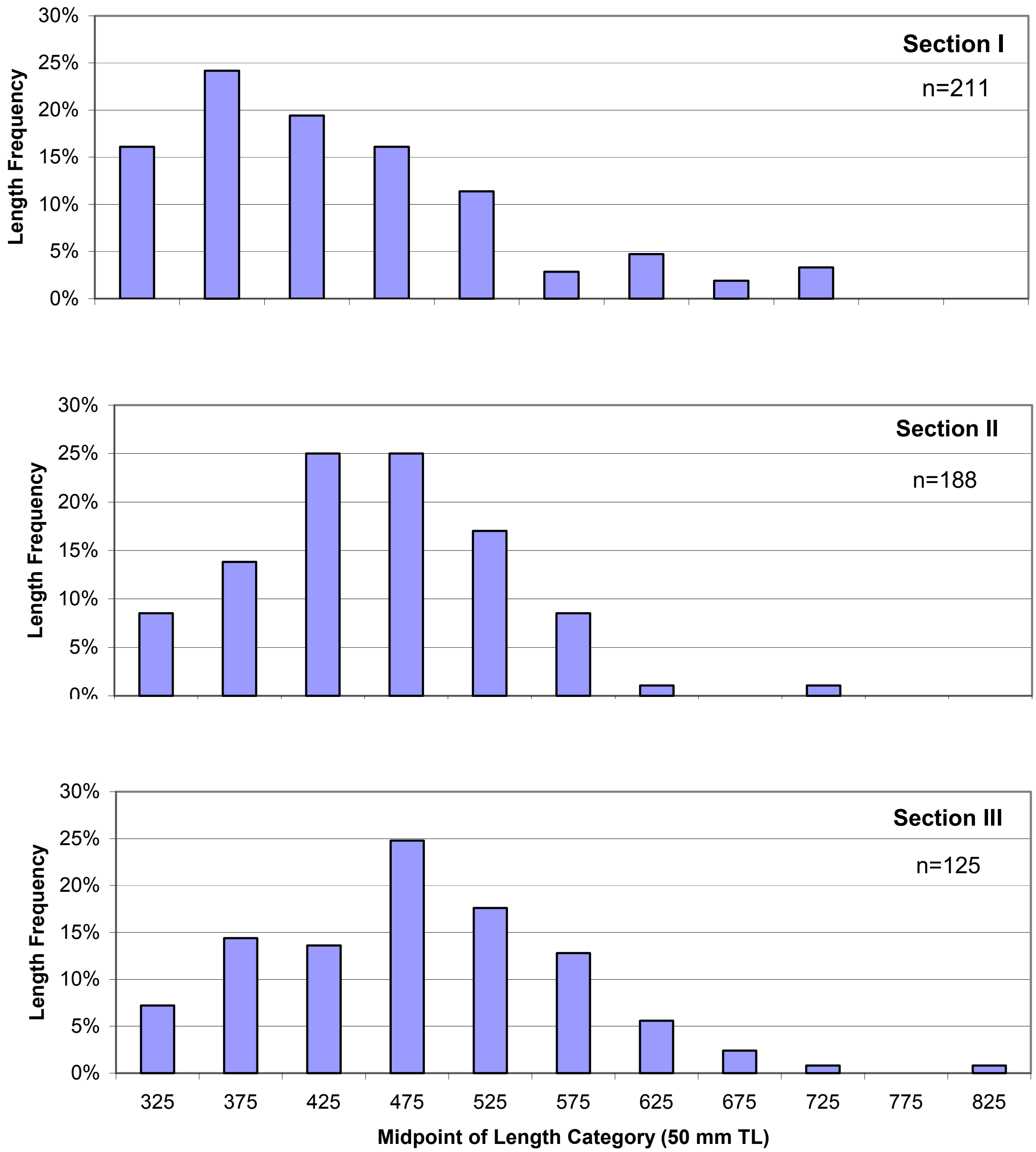

Figure 4.–Length-frequency distributions of burbot sampled from the Copper River, 2003.

Table 2.-Length of sections, dates of sampling, number of sets and number of burbot caught by length category and proportion of burbot sampled ≥ 700 mm TL by sampling section in the Copper River, 2003.

	Section			
	I	II	III	All
Length:	27 miles	22 miles	38 miles	87 miles
Dates of Sampling:	11-15 Aug	18-22 Aug	22-26 Aug	11-26 Aug
Number of Sets:	109	114	123	346
Number of Burbot Caught by Length Category (mm TL):				
300-349	34	16	9	59
350-399	51	26	18	95
400-449	41	47	17	105
450-499	34	47	31	112
500-549	24	32	22	78
550-599	6	16	16	38
600-649	10	2	7	19
650-699	4	0	3	7
700-749	7	2	1	10
750-799	0	0	0	0
800-849	0	0	1	1
≥ 850	0	0	0	0
All Lengths	211	188	125	524
Adults ≥ 450 mm	85	99	91	275
Adults ≥ 700 mm TL:				
Number	7	2	2	11
$\hat{p}$	0.082	0.020	0.022	0.040
SE[$\hat{p}_i$]	0.030	0.014	0.015	0.012

Table 3.–Estimated mean CPUE (fish per net-night) of immature, small adult and large adult burbot in standardized hoop trap sets by study section in the Copper River, 2003. Standard errors are in parentheses.

	Section						ALL	
	I		II		III			
Overnight Sets:	104		113		121		338	
CPUE of Immature Burbot (300 – 499 mm TL):	1.21	(0.14)	0.76	(0.11)	0.38	(0.07)	0.56	(0.06)
CPUE of Small Adult Burbot (450 – 699 mm TL):	0.76	(0.14)	0.83	(0.12)	0.65	(0.09)	0.75	(0.07)
CPUE of Large Adult Burbot (≥ 700 mm TL):	0.07	(0.03)	0.02	(0.01)	0.02	(0.01)	0.04	(0.01)

Table 4.–Estimated mean CPUE by water body for immature, small adult and large adult burbot captured in Section I in the Copper River drainage, 2003.

Water Body	Overnight Sets	Immature 300-449 mm TL	Small Adults 450 – 699 mm TL	Large Adults ≥ 700 mm TL
Slana River	71	1.51	0.96	0.10
Mainstem Copper River	33	0.58	0.30	0.00
Total	104	1.21	0.76	0.07

DISCUSSION

This study revealed that size composition of the burbot population in the Copper River was skewed towards immature fish and away from large adults. Alternative explanations for such a distribution are: 1) sampling favored the capture of smaller fish; 2) sampling disfavored the capture of larger burbot; 3) high exploitation rates in a fishery have culled off larger burbot; 4) a high natural mortality rate; 5) smaller fish belong to strong, recent year classes; or, 6) larger fish belong to weak, earlier year classes. Some of these alternatives can be readily rejected. Studies into selectivity of the sampling procedures and the sampling gear used in our study were conducted on the Tanana River (Bernard et al. 1991) with the conclusion that immature burbot have a lower probability of being caught than do larger burbot. The reason given was that immature burbot as a group are not fully committed to piscivory, meaning that many are disinclined to enter traps baited only with herring. These same studies showed that the probability of capturing extremely large burbot (≥ 800 mm TL) was 40% less than the probability of capturing smaller, adult burbot in traps similar to those used in our study. In our study 4% of captured adults were large adults (≥ 700 mm TL). Prorating 4% by a 40% reduction in the probability of capture would increase the percentage to 9%. Even with this unsubstantiated extension of selectivity down to 700 mm TL, the expanded percentage is not great enough to keep size-selective sampling as an explanation for our results. High harvests rates can be rejected as a likely explanation as well, given the negligible harvests reported in Table 1 relative to the number of burbot in the population implied by the CPUE in our study.

Confirmation of one of the remaining alternatives (and rejection of the others) requires information not available at this time. Average instantaneous natural mortality rates in populations of burbot in lakes not subject to summer kill in the Copper River watershed have ranged an estimated 0.44 to 0.51 (calculated from Parker et al. 1989). No specific information is available on the natural mortality rate for burbot in the Copper River. Evenson (1998) used 0.46 in his calculations for the Tanana River. An alternative to a high rate of natural mortality for explaining the small proportion of large fish captured is a slow growth rate for individual burbot. No data are available on the growth for burbot in the Copper River. Such data could be obtained through determination of age (most likely sacrificing captured fish to obtain otoliths) or through directly measuring growth from fish recaptured in future studies. A likely scenario for growth by age for large adults to comprise 4% of the adult population with no exploitation as observed in our study would require an instantaneous natural mortality rate of 0.60 (see Appendix B). While variation in relative year-class strengths could have produced the size distributions we observed, information on these relative strengths is also lacking.

What to make of trends in estimated mean CPUE is not clear. Statistics for burbot in the Copper River are different than those experienced in the Tanana River (see Evenson 1993 and 1998, Tables 3 and 4; Appendix B). Our study generally produced higher mean CPUE for immature burbot and lower for adults, especially large adults. Being that mean CPUE is a function of both density and catchability of burbot, no clear-cut comparison based on either factor is possible. Results reported in Evenson (1993; Table 4) for the sole instance of repeat sampling in the same area with the same gear (August 1990) show that mean CPUE of adult burbot can increase dramatically in the same area in a short time (2.5 times from 0.41 to 1.01 fish per net-night based on two weekly surveys with just over 200 sets each week). Some use of larger hoop traps on the Tanana River and sampling during months before and after August also compromise a direct comparison. However, if the comparison is limited to information on catches in the smaller hoop traps used in our study, average mean CPUE was about four small adults per five over-night sets (calculated from Evenson 1998). Our average mean CPUE for the same group was about the same (0.79 adults per net-night). Fortunately, variability in mean CPUE appears not to affect estimated size composition within a sampling event.

The goal of this project was to acquire the capability to detect overharvest from burbot population(s) in the Copper River drainage should effort and harvest increase in future years. Overharvest was defined as a harvest that would push the number (or biomass) of adult burbot below the point that would be expected to produce maximum surplus production (half the biomass experienced with no exploitation). Using information in Evenson (1998) as a surrogate for information on burbot in the Copper River, a population comprised of 8% large adults was used to typify an unexploited population and a population comprised of 1% large adults to typify of a population exploited at a level to produce maximum surplus production (see Appendix B). Unfortunately the estimated fraction of large adults in the Copper River was not 8%, but half that. That implies an instantaneous rate of natural mortality at 0.60 instead of the 0.46 used to plan our study. With an instantaneous fishing rate at 0.60, only 0.2%, virtually no large adults would be expected to be in the population. Under these circumstances 180 adults need to be captured in 2003, and again in a future year, to meet objective criteria of 90% power of detecting a difference and a 5% chance of detecting a "difference" not there (see Appendix B). That criterion was easily surpassed with the 265 adult burbot caught in 2003 in 338 over-nights sets. Since the population abundance should be no more than halved when the fishing and natural mortality rates are equal, expected mean CPUE should be no worse than half that experienced in 2003, or about 0.40 adult burbot per set. Under these circumstances about the same sampling effort in 2003 (346 sets) should be sufficient to capture 180 adults in a future year unless overharvest is extreme. In this case the testing metric could be lowered from 700 mm TL to a smaller length.

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APPENDIX A

Appendix A1.–Data files pertaining to the 2003 Copper River burbot study that are archived by the Research and Technical Services of the Alaska Department of Fish and Game-Sport Fish Division.

Location:	Contact Person:	Storage Software:
Fairbanks	*Corey Schwanke* *907-822-3309*	*Delimited ASCII files*

Area	File Name	Data Format	Software
Section I	i-014101h012003.dta	Hoop net	RTS-ASCII
Section II	i-014101h022003.dta	Hoop net	RTS-ASCII
Section III	i-014101h032003.dta	Hoop net	RTS-ASCII

Definition of data formats:

Hoop net: a mark-sense form developed by Alaska Department of Fish and Game, Division of Sport Fish Research and Technical Services (RTS) for the recording of trap, catch, and tagging information. Specific codes and organization of columns for data format is available on request.

APPENDIX B

Appendix B1.–Calculations for establishing sample sizes.

Panel B.1.–Estimation of the target number of burbot needed to be sampled to detect a shift in size composition of adult burbot in the Copper River commensurate between the population being unexploited to being exploited to produce maximum surplus production. Fraction of the adult (5+ years old) population comprised of large adult burbot (≥ 700 ml TL) is the metric. Statistics on asymptotic length (L_{inf}), the growth coefficient (K), the instantaneous natural mortality rate (M), and time at length 0 (t_o) were taken or derived from information given in Evenson (1998). Abundance for calculations below was arbitrarily set to 100 at age 6. In this panel M = 0.46 as surmised from an average of 8% of adult burbot captured in the Tanana River being large adults. The top bank of numbers reflect population statistics by age with no exploitation; the bottom bank reflects statistics by age when the instantaneous rate of fishing mortality (F) equals M. Actual sample size is determined with an algorithm on sample sizes for 2x2 contingency tables in Steel and Torrie (1980, p. 516) given desired power (90%) and probability of making a Type I error (5%).

Panel B.2.–Same analysis as in Panel A.1 only M = 0.60 as surmised from the estimated fraction of adult burbot comprised of large adults (4%) in sampling from the Copper River in 2003.

-continued-

Panel B.1

Instantaneous Natural Mortality Rate ----->	0.46	3.9517E-09 <---	Solver Cell for *K*:
Instantaneous Fishing Mortality Rate ----->	0.46	1000 <---	*L(inf):*
Instantaneous Total Mortality Rate ----->	0.92	-0.1367 <---	*K:*
Survival Rate (Juveniles) ----->	0.631	1.75 <---	*T(o):*
Survival Rate (Adults) ----->	0.399 (with fishing)		

= Small Adults
= Large Adults

Age	"Abundance"	Relative Catchability	Sample "Catch"	Relative Age Composition of Sample	% Age Composition by Size	Length	"Biomass"
5	158.4					359	7312749807
6	100.0	1.0	100.0	0.379	0.924	441	8557353450
7	63.1	1.0	63.1	0.239		512	8479841470
8	39.9	1.0	39.9	0.151		574	7555526043
9	25.2	1.0	25.2	0.095		629	6256197442
10	15.9	1.0	15.9	0.060		676	4912053237
11	10.0	1.0	10.0	0.038	0.076	718	3705419120
12	6.3	1.0	6.3	0.024		754	2710011485
13	4.0	0.4	1.6	0.006		785	1934143930
14	2.5	0.4	1.0	0.004		813	1353570848
15	1.6	0.4	0.6	0.002		837	932255960
16	1.0	0.4	0.4	0.002		857	633697413

Z(beta)→	1.285	Fraction > 699 mm	
Z(alpha) →	1.645	0.076	← No Harvest
Target Catch→	128	0.009	← Maximum Surplus Production

Age	"Abundance"	Relative Catchability	Sample "Catch"	Relative Age Composition of Sample	% Age Composition by Size	Length	"Biomass"
5	158.4					359	7312749807
6	100.0	1.0	100.0	0.602	0.991	441	8557353450
7	39.9	1.0	39.9	0.240		512	5353185236
8	15.9	1.0	15.9	0.096		574	3011020994
9	6.3	1.0	6.3	0.038		629	1573925100
10	2.5	1.0	2.5	0.015		676	780119652
11	1.0	1.0	1.0	0.006	0.009	718	371501037
12	0.4	1.0	0.4	0.002		754	171521419
13	0.2	0.4	0.1	0.000		785	77278833
14	0.1	0.4	0.0	0.000		813	34141083
15	0.0	0.4	0.0	0.000		837	14844173
16	0.0	0.4	0.0	0.000		857	6369822

-continued-

Panel B.2

Instantaneous Natural Mortality Rate ----->	0.60	3.9517E-09	<-- Solver Cell for *K*:
Instantaneous Fishing Mortality Rate ----->	0.60	1000	<-- *L(inf):*
Instantaneous Total Mortality Rate ----->	1.2	-0.1367	<-- *K:*
Survival Rate (Juveniles) ----->	0.549	1.75	<-- *T(o):*
Survival Rate (Adults) ----->	0.301 (with fishing)		

= Small Adults
= Large Adults

Age	"Abundance"	Relative Catchability	Sample "Catch"	Relative Age Composition of Sample	% Age Composition by Size	Length	"Biomass"
5	182.2					359	8411664500
6	100.0	1.0	100.0	0.456	0.959	441	8557353450
7	54.9	1.0	54.9	0.250		512	7372020017
8	30.1	1.0	30.1	0.137		574	5710343742
9	16.5	1.0	16.5	0.075		629	4110614634
10	9.1	1.0	9.1	0.041		676	2805809331
11	5.0	1.0	5.0	0.023	0.041	718	1840056680
12	2.7	1.0	2.7	0.012		754	1169940477
13	1.5	0.4	0.6	0.003		785	725905684
14	0.8	0.4	0.3	0.001		813	441642818
15	0.5	0.4	0.2	0.001		837	264438157
16	0.2	0.4	0.1	0.000		857	156267858

Z(beta)→	1.285	Fraction > 699 mm	
Z(alpha) →	1.645	0.041	← No Harvest
Target Catch→	180	0.002	← Maximum Surplus Production

Age	"Abundance"	Relative Catchability	Sample "Catch"	Relative Age Composition of Sample	% Age Composition by Size	Length	"Biomass"
5	182.2					359	8411664500
6	100.0	1.0	100.0	0.699	0.998	441	8557353450
7	30.1	1.0	30.1	0.211		512	4045850367
8	9.1	1.0	9.1	0.063		574	1719922483
9	2.7	1.0	2.7	0.019		629	679480029
10	0.8	1.0	0.8	0.006		676	254537280
11	0.2	1.0	0.2	0.002	0.002	718	91611028
12	0.1	1.0	0.1	0.001		754	31967129
13	0.0	0.4	0.0	0.000		785	10885374
14	0.0	0.4	0.0	0.000		813	3634609
15	0.0	0.4	0.0	0.000		837	1194356
16	0.0	0.4	0.0	0.000		857	387349